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New dinosaur bones from the Dinosaur Provincial Park (Alberta, Canada) expedition of 1922

Abstract - Here are described five dinosaur postcranial bones that were collected by the Field Museum Paleontological Expedition of 1922 to the Red Deer River (Alberta, Canada), in which the famous fossil collector George F. Sternberg took part. The locality lies in the Dinosaur Park Formation (Campanian, Upper Cretaceous), and the families determined are: Ceratopsidae, Hadrosauridae, Ankylosauridae, and Ornithomimidae.

Key words: Dinosaur Park Formation, Sternberg, Ceratopsidae, Hadrosauridae, Ankylosauridae, Ornithomimidae.

Riassunto - Nuove ossa di dinosauro provenienti da una spedizione del 1922 nel Dinosaur Provincial Park (Alberta, Canada).

Vengono qui descritte cinque ossa postcraniali di dinosauro recuperate nel 1922 da una spedizione paleontologica del Field Museum nei pressi del fiume Red Deer (Alberta, Canada), alla quale prese parte anche il famoso cercatore di fossili George F. Sternberg. Il giacimento fossilifero fa parte della Dinosaur Park Formation (Campaniano, Cretacico superiore), e le famiglie a cui appartengono i reperti sono: Ceratopsidae, Hadrosauridae, Ankylosauridae e Ornithomimidae.

Parole chiave: Dinosaur Park Formation, Sternberg, Ceratopsidae, Hadrosauridae, Ankylosauridae, Ornithomimidae.

Introduction

A skeleton of the duckbilled dinosaur *Gryposaurus notabilis* was collected by J.B. Abbot during the Field Museum Paleontological Expedition of 1922 to the badlands along the Red Deer River (Alberta, Canada) in which George F. Sternberg took part. He was the first of three sons of Charles H. Sternberg, and was engaged by the Chicago Field Museum both for his great experience in the field and his talent in collecting fossils. The material recovered during that expedition was transported to the Chicago Field Museum, and remained stored in the collections, contained within the original field jackets for several decades. Those jackets were

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shipped in twelve boxes to the Museo Civico di Storia Naturale of Milan in October 1958, in exchange for paleontological material. After being prepared and studied (Vialli, 1960; Pinna, 1979), the specimen MSNM V345 *Gryposaurus notabilis* was exhibited to the public in the exhibits of the museum (Arduini & Pinna, 1982) from 1964 to 1991. Subsequently, the skeleton was removed from exhibit, and the bones were stored in the collection, where they remained until the year 2000. In that year, the paleontologists of the museum decided to construct a natural-sized diorama featuring a 1922 George F. Sternberg in the field, with the outcropping gryposaur skeleton. While a cast of the gryposaur skeleton was being made, some isolated bones, labelled as "fragmentary material" and that clearly did not pertain to the specimen MSNM V345, were found. Those forgotten bones were not mentioned in both the papers on the MSNM V345 osteology (Vialli, 1960; Pinna, 1979). The purpose of the present paper is to identify and describe this old but virtually new material that has come to light for the second time.

Fossil location and history

Some labels found in the collection of the Museo Civico di Storia Naturale of Milan indicate that the isolated bones were collected by the Field Museum Paleontological Expedition of 1922, together with the specimen MSNM V345 *Gryposaurus notabilis*. Although the expedition of 1922 remains almost undocumented, Darren Tanke of the Royal Tyrrell Museum of Palaeontology (Drumheller, Canada), discovered some elements (fragments of glass, pieces of newspaper, tools) abandoned in the field during the past paleontological digs. Thanks to both these elements and old photos, within a few years 13 lost or mystery quarries had been solved (Tanke, 2001), with 25 identified to date (Tanke, submitted). Among the solved quarries, there is the site now staked as 'Quarry 137, 1922 Chicago Field Museum expedition to Dinosaur Provincial Park' (Fig. 1), from which comes the specimen MSNM V345 *Gryposaurus notabilis*. Anyway it is very difficult assessing if the isolated bones were part of Quarry 137. Field data from the 1922 expedition were lost or not recorded, so the original position of the bones remains unknown. Unfortunately, we lack also detailed data of the preparation, so that it is impossible to know the exact contents of the twelve boxes, i.e. if the isolated bones arrived in Milan in jackets together with the gryposaur ones, or if they were in their own jackets. At the moment, the more plausible explanation is that the isolated bones come from or near the rich multigeneric bonebed that is right at the site of the Quarry 137 (D. Tanke, pers. comm.).

Geological setting

The Dinosaur Park Formation (nonmarine Judith River Group [Campanian], southeastern Alberta) is an 80 m thick formation characterized by thick grey sandstones, red-brown ironstones and siltstones, green-to-brown claystones and thin coals that form layers of rock in which are commonly found both the remains of articulated dinosaurs, monospecific (i.e. ceratopsian), and multigeneric bone beds. The Dinosaur Park Formation is largely made up of sediments deposited by deep,

meandering rivers that originated in the north and central Cordillera and flowed southeastward, subparallel to the axis of the Alberta Basin (Eberth & Hamblin, 1993), 76.5 to 74.5 million years ago.

Fig. 1 - 'Quarry 137, 1922 Chicago Field Museum expedition to Dinosaur Provincial Park', from which comes the specimen MSNM V345, *Gryposaurus notabilis*. The bones described in this paper come from this site or from a multigeneric bonebed in its neighbourhood. The vertical structure is a metal marker or "quarry stake" marking the quarries location. The base of the massive white sandstones marks the contact between the Oldman Formation (below) and Dinosaur Park Formation.
Fig. 1 - 'Quarry 137, 1922 Chicago Field Museum expedition to Dinosaur Provincial Park', dalla quale proviene l'esemplare MSNM V345, *Gryposaurus notabilis*. Le ossa descritte in questo articolo provengono da questo sito o da un cimitero di ossa appartenenti a più generi situato nelle sue vicinanze. La struttura verticale è un marcatore metallico detto "quarry stake" che serve per marcare il sito di scavo. La base del massiccio strato di arenaria bianca segna il contatto fra la Oldman Formation (sotto) e la Dinosaur Park Formation.

Material and methods

The material here described is housed in the Collection of Fossil Vertebrates of the Museo Civico di Storia Naturale of Milan (MSNM V). It consists of five isolated postcranial elements that are assignable to four different dinosaur families. The bones defy diagnosis to genus level, but are sufficiently preserved to allow morphological comparison with the bones of some well-known dinosaur taxa already listed from the Dinosaur Park Formation (Table I). The tentative classification here proposed is largely based on the results of this comparison.

Tab. I - Summary list of the dinosaurs from the Dinosaur Park Formation (Alberta, Canada) that are comparable with the new five specimens. Modified from Ryan & Russell (2001).
Tab. I - Lista riassuntiva dei dinosauri provenienti dalla Dinosaur Park Formation (Alberta, Canada) che sono comparabili con i cinque nuovi esemplari. Modificata da Ryan & Russell (2001).

Specimen	**Family**	**List of the species from the Dinosaur Provincial Park belonging to the family**
MSNM V5177	Hadrosauridae	*Brachylophosaurus canadensis* *Gryposaurus notabilis* *"Kritosaurus" incurvimanus* *Prosaurolophus maximus* *Corythosaurus casuarius* *Lambeosaurus lambei* *L. magnicristatus* *Lambeosaurus* n. sp. *Parasaurolophus walkeri*
MSNM V5175	Ceratopsidae	*Centrosaurus apertus*
MSNM V5176		*Styracosaurus albertensis* *Chasmosaurus belli* *C. russelli* *C. irvinensis*
MSNM V5179	Ankylosauridae	*Euoplocephalus tutus*
MSNM V5178	Ornithomimidae	*Dromiceiomimus samueli* *Ornithomimus edmontonensis* *Struthiomimus altus*

Systematic paleontology

DINOSAURIA Owen 1842
ORNITHISCHIA Seeley 1888
CERATOPSIDAE Marsh 1888

Material: specimen MSNM V5175, ?right tibia fragment; specimen MSNM V5176, right tibia.

Description: while the specimen MSNM V5175 (Fig. 2a) is fragmentary, it compares favourably with ceratopsian tibia MSNM V5176 and is therefore tentatively referred to belonging to a ?right ceratopsian tibia. Only the fragmentary, distal half of the bone is preserved, measuring 270 mm in length. Distally, a little portion of the area for the contact with the astragalus can be seen, but due to both the incompleteness and the bad state of preservation of the bone nothing more can be said.

The specimen MSNM V5176 (Figs. 2b, 2c) is a right tibia. It is stout and short, and clearly pertains to the Ceratopsidae. Like in other ceratopsids (Hatcher *et al.*, 1907; Penkalski & Dodson, 1999), it is constricted medially and expanded mediolat-

erally at either extremity. It closely resembles the tibia of the medium-sized ceratopsian genera, like *Monoclonius* (Hatcher *et al.*, 1907), in being stouter and shorter than the one of *Avaceratops* (Penkalski & Dodson, 1999) but less massive than the one of the giant ceratopsids like *Triceratops* (Hatcher *et al.*, 1907). This specimen is undistorted and quite well preserved: the proximal end is largely complete, it bears the cnemial crest and the internal and lateral condyles, and only some margins are missing; the distal end lacks both the malleoli and some portion of the area for the contact with the fibula. Due to the fractures the tibia measures 462 mm in length, but I estimate that the complete bone was about 530 mm long (based on *Monoclonius*) and it could pertain to an individual about 4.5 m long, thus resulting in the adult size range for the ceratopsids from the Dinosaur Park Formation (Table I).

DINOSAURIA Owen 1842
ORNITHISCHIA Seeley 1888
HADROSAURIDAE Cope 1869

Material: specimen MSNM V5177, left radius.

Description: the specimen MSNM V5177 (Figs. 2d; 2e) is a left radius, and measures 275 mm in length. It can be assigned to the Hadrosauridae for its closely resemblance to the radii of the dinosaurs belonging to this family (Lull & Wright, 1942). However, based only on the morphology of this bone, there are not enough characters to justify its attribution to the subfamilies Hadrosaurinae or Lambeosaurinae. As in other hadrosaurids (Lull & Wright, 1942; Pinna, 1979), the bone is slender, mainly cylindrical and slightly sigmoid. The surface of the condyles is ablated, apparently weathered on the outcrop prior to discovery. The proximal end is expanded craniocaudally and subrectangular in cross-section, wider cranially than caudally, and caudolaterally forms a concave facet for the contact with the proximal end of the ulna. Its articular face presents a central depression for the lateral epicondyle of the humerus. The shaft is flattened proximally, slightly concave on the lateral side (area for the contact with ulna), then it becomes gradually subcircular in cross-section. The distal end is ovoid in cross-section and ends in an expanded, roughened convex articulation for the carpus. The ventrolateral surface is covered by plaster that masks the shallow flattened area that articulates with the distal end of the ulna. Taking into account the adult size of the known hadrosaurids from the Dinosaur Park Formation (Table I), the relatively small size of MSNM V5177 indicates that it could pertain to a juvenile or subadult individual, maybe less than 4 m long.

DINOSAURIA Owen 1842
ORNITHISCHIA Seeley 1888
?ANKYLOSAURIDAE Brown 1908
?*Euoplocephalus* Lambe (1910)
(The following junior objective synonym: *Stereocephalus* Lambe 1902/Arribalzaga 1884)
?*Euoplocephalus tutus* Lambe (1902)
(The following junior objective synonym: *Stereocephalus tutus* Lambe 1902)

Material: specimen MSNM V5179, ?left ischium.

Description: due to the incompleteness of both the extremities, to the large

amount of plaster in some points, and to the lack of diagnostic features, the specimen MSNM V5179 (Figs. 2h, 2i, 2l, 2m) is more difficult to identify. It consists of a 435 mm long, slender, and mediolaterally flattened bone, which is craniocaudally expanded at its proximal end. At a first look, the specimen shows some resemblance with both an ornithomimid scapula and an ornithischian ischium. Its shape (Figs. 2i, 2m) resembles that of the right scapulae of *Gallimimus* and *Struthiomimus* (Barsbold & Osmolska, 1990), which have low and slender profile, high acromion, and lack distal expansion. However, in MSNM V5179 the distal end is rounded and not flat in cross-section (Fig. 2j), and there are no traces of the glenoid cavity, whereas there would be seen at least its caudal margin. For these reasons it is quite improbable that the specimen is really an ornithomimid scapula, and its attribution to the Ornithomimidae can be rejected almost definitely.

The second above-mentioned hypothesis is that the bone is an ornithischian ischium. Actually, the whole shape of the specimen better supports its attribution to the Ankylosauridae on the basis of the close resemblance with the ischia of other ankylosaurids (Coombs, 1986; Coombs & Maryanska, 1990; Carpenter *et al.*, 2001). The proximal margin of the bone shows no traces of an opened acetabulum, indicating that MSNM V5179 pertains without doubt to the Ankylosauria, that is the only group of ornithischian dinosaurs with an acetabulum completely closed (Coombs & Maryanska, 1990). Among the ankylosaurs, the attribution of the specimen MSNM V5179 to the Nodosauridae can be excluded, because it lacks the sharp ventral flexion at about the midlength of the shaft, typical of nodosaurids (Coombs & Maryanska, 1990). Furthermore, being *Euoplocephalus tutus* the only species of the Ankylosauridae known from the Dinosaur Park Formation, the specimen MSNM V5179 can be tentatively referred to an adult individual of this taxon. The ischia attributed to *Euoplocephalus* in Coombs & Maryanska (1990) and Coombs (1986) show some differences in both the proportion and the curvature of the shaft. Being MSNM V5179 more similar to the ischium figured by Coombs & Maryanska (1990), in the following description it has been considered a ?left ischium. In lateral view, contrary to the specimen described by Coombs (1986), the cranial margin of the shaft is a little concave cranially. The caudal margin of the shaft is parallel to the cranial one for 3/4 of its length, but it slopes caudally just below the acetabulum. The lateral surface of the bone (Fig. 2i) is slightly concave proximally, and, as in other Ankylosauria (Coombs & Maryanska, 1990), it forms most of the vertical wall of the acetabulum. However, due to the compression in the fossilization, the bone is somewhat distorted and medio-laterally crushed, so that it cannot be seen a clear fossa for the acetabulum. On the medial surface of the ischium (Fig. 2k) there is a deep incision that runs dorsoventrally along the mid part of the bone. The dorsal surface is wider caudally than cranially, in correspondence of the area for the attachment of the ilium.

DINOSAURIA Owen 1842
SAURISCHIA Seeley 1888
THEROPODA Marsh 1881
ORNITHOMIMIDAE Marsh 1890 *sensu* Smith & Galton 1990

Material: specimen MSNM V5178.

Description: this specimen (Figs. 2f, 2g), 380 mm long, is an ornithomimid left pubis. The wide distal end is broken and the pubic boot is eroded off; for this rea-

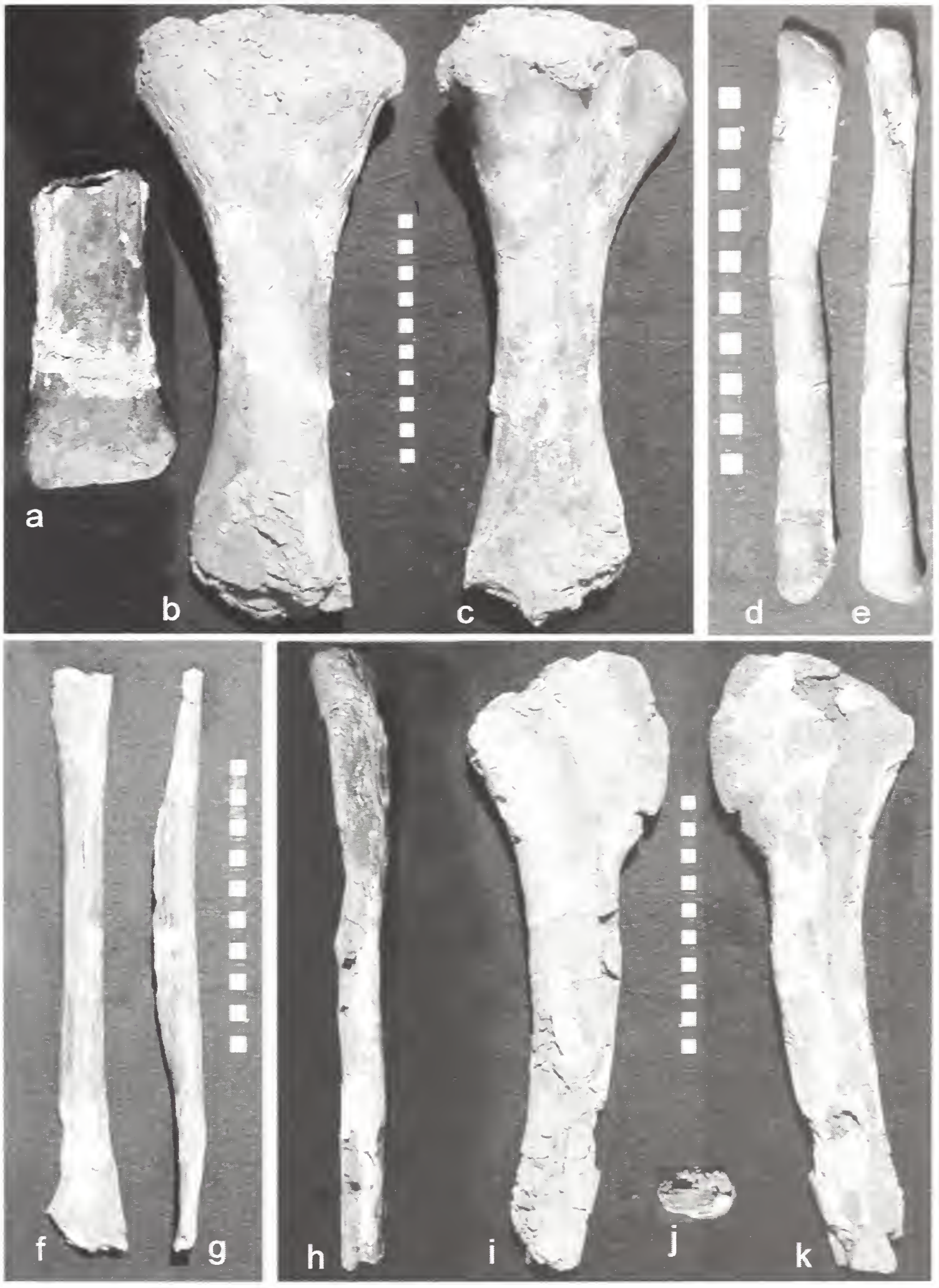

Fig. 2 - Dinosaur postcranial bones from the Dinosaur Park Formation (Alberta. Canada): a) caudal view of ?ceratopsian tibia MSNM V5175: b. c) cranial and caudal views of ceratopsian tibia MSNM V5176: d. e) medial and caudal views of hadrosaur radius MSNM V5177: f. g) medial and cranial views of ornithomimid pubis MSNM V5178: h. i. j. k) posterior. medial. ventral. and lateral views of ?ankylosaur ischium MSNM V5179. Scale bars are in cm.

Fig. 2 - Ossa postcraniali di dinosauro provenienti dalla Dinosaur Park Formation (Alberta. Canada): a) vista caudale della ?tibia di ceratopside MSNM V5175: b. c) vista craniale e caudale della tibia di ceratopside MSNM V5176: d. e) vista mediale e caudale del radio di adrosauride MSNM V5177: f. g) vista mediale e craniale del pube di ornitomimide MSNM V5178: h. i. j. k) vista posteriore. mediale. ventrale e laterale dell'ischio di ?anchilosauride MSNM V5179. Le scale metriche sono in cm.

son nothing can be said about the shape of the boot and the angle between its anteroposterior axis and the pubic shaft. The proximal end is also missing, so that the articular surfaces for the ilium and the ischium cannot be observed. As in other ornithomimids (Barsbold & Osmolska, 1990; Kobayashi & Lü, 2003), the bone is straight, long and slender, mediolaterally flattened at both the extremities, and it bears a crest projecting from its medial surface. Medially, this crest encountered its counterpart from the right pubis to form the pubic apron. The crest originates 67 mm from the proximal broken margin of the bone, runs along the entire medial surface of the pubic shaft, and terminates near the pubic boot. The size of the bone indicates that it could pertain to an individual about 3 m long, that is just the medium size reported for the adult ornithomimids (Barsbold & Osmolska, 1990) from the Dinosaur Park Formation.

Conclusions

These isolated bones do not offer new information on the anatomy of the dinosaurs to which they pertain, but certainly, being a sample of the extraordinary variability of the rich fauna of the Dinosaur Park Formation, they increase the value of the dinosaur collection stored in the Museo Civico di Storia Naturale of Milan. Their importance is also linked to the historical context in which they were discovered and, as a consequence, to the little but not negligible contribution in the identification and relocation of all the material collected in the Dinosaur Provincial Park in the past centuries.

In a particular way, the specimen MSNM V5179 represents an unusual finding, because it is very rare to find ankylosaurid ischia isolated from the rest of the skeleton. Darren Tanke (pers.comm.) reported only one isolated ankylosaur ischium from Dinosaur Provincial Park in the last 25 years.

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